THE WORK OF THE NATIONAL COMMITTEE ON MATHEMATICAL REQUIREMENTS.

The National Committee on Mathematical Requirements was organized in the fall of 1916 under the auspices of the Mathematical Association of America in response to an insistent demand that national expression be given to various movements looking towards reform in the teaching of mathematics which had gained more or less headway through the activities of various local organizations throughout the country. The Committee was instructed to investigate the whole field of mathematical education from the secondary school through the college and to make recommendations looking toward a desirable reorganization of courses and the improvement of teaching.

The original nucleus of the Committee consisted of six college professors who were appointed by Professor E. R. Hedrick, then President of the Mathematical Association. This group held its first meeting in September, 1916, at Cambridge, Mass., at which time steps were taken to secure adequate representation of secondary school interests and general plans for the work were formulated. The three large organizations of secondary school teachers of mathematics, viz., the Association of Teachers of Mathematics in New England, the Association of Teachers of Mathematics in the Middle States and Maryland and the Central Association of Science and Mathematics Teachers, were each requested to appoint an official representative on the Committee. Since then four additional representatives of secondary schools have been appointed.*

* The present membership of the Committee consists of the following: A. R. Crathorne, University of Illinois; C. N. Moore, University of Cincinnati; E. H. Moore, University of Chicago; D. E. Smith, Columbia University; H. W. Tyler, Massachusetts Institute of Technology; J. W. Young, Dartmouth College (chairman); W. F. Downey, English High School, Boston, representing the Association of Teachers of Mathematics in New England; Vevia Blair, The Horace Mann School, New York City, representing the Association of Teachers of Mathematics in the Middle States and Maryland; J. A.

It soon became apparent to the Committee that it could not hope to do its work with the necessary thoroughness or effectiveness without adequate financial support. Furthermore, the war naturally interfered with its work. Many of its members were engaged in war work of one kind and another and the remaining members were carrying a double burden in view of the fact that all educational institutions were greatly undermanned during this period. In the early spring of 1919, however, the Committee was fortunate in interesting the General Education Board of New York City in its work. As a result the Board appropriated the sum of $16,000 for the use of the Committee for one year ending July 1, 1920, and appropriated the further sum of $25,000 to complete the work.

This generous support made it possible to plan the work of the committee on a much larger scale. It made it possible to secure the full-time service of the chairman and vice-chairman; to rent and equip suitable offices; to employ the necessary stenographic and other clerical help; to pay the traveling expenses of members in attending meetings of the committee, etc. It also made it possible to finance numerous meetings of subcommittees, personal conferences and the like, and to pay the necessary expenses of representatives of the committee in attending and addressing meetings of various teachers' associations throughout the country. It is probably true that this is the first committee engaged upon a specific educational problem which has had adequate financial resources.

It was felt very strongly that the committee should not attempt to do the work assigned to it alone but that it should take steps to secure the active cooperation of teachers of math-

Foberg, Crane Technical High School, Chicago (vice-chairman), representing the Central Association of Science and Mathematics Teachers; A. C. Olney, Commissioner of Secondary Education, Sacramento, California; Raleigh Schorling, The Lincoln School, New York City; P. H. Underwood, Ball High School, Galveston, Texas; Eula A. Weeks, Cleveland High School, St. Louis, Mo. (Professor C. N. Moore was appointed to take the place of Professor Oswald Veblen, of Princeton University, who felt called upon to resign as a member of the Committee on account of his war duties Mr. G. W. Evans, of the Charlestown High School, Boston, Mass., was originally appointed as the representative of the New England Association. Owing to his absence from the country for over a year, his place was taken by Mr. Downey.)

ematics and school administrators throughout the country. This seemed necessary both for the purpose of securing their advice and constructive criticism and also in order to stimulate widespread interest and support so that the recommendations of the committee might be put into practice with the least possible delay. The attempt was therefore made to organize a truly nation-wide study and discussion of the problems of mathematical instruction. The response secured in this attempt was very gratifying. At the present time nearly one hundred organizations of teachers are cooperating with us.* Many of these have appointed special committees for this purpose. Our reports are submitted to these cooperating committees in preliminary form for their approval, comment, criticism and advice. The Committee is therefore acting in a very real sense as a national clearing-house for ideas relating to its problems. As a result it may confidently be expected that our final recommendations will have the support of the great majority of progressive teachers throughout the country; in fact, one of the most encouraging features of the Committee's work up to the present has been the very general agreement that has been found to exist among teachers. There is, of course, some difference of opinion as to details; but as to broad general lines of purpose and policy there is substantial unanimity.

It has been possible to secure wide publicity. Our reports have been presented and discussed at meetings of all the organizations previously referred to. "Notes and News" relating to our work have appeared at frequent intervals in some fifty educational periodicals. Above all, however, we are indebted to Commissioner P. P. Claxton and the U. S. Bureau of Education for the assistance given us by the publication and wide distribution of our reports. This service has been of inestimable value.

As to the present status of the work of the Committee, a list of reports, published or in preparation, with brief indications of their content, should be of interest.

The first five reports are intended to cover the field assigned

* The list of cooperating organizations includes 31 state teachers' associations, 25 associations and societies of teachers of mathematics (or of mathematics and science), local councils or clubs in 20 cities, and others.

to the Committee as to content and organization of courses. The first two have already been published.

1. "*The Reorganization of the First Courses in Secondary School Mathematics*," a preliminary report, published by the U. S. Bureau of Education as Secondary School Circular No. 5, February, 1920.
2. "*Junior High School Mathematics*," a preliminary report published by the U. S. Bureau of Education as Secondary School Circular No. 6, July, 1920.

The first of these considers the reorganization of courses in mathematics in the first two years of the standard four-year high school; that is, courses for the ninth and tenth grades. The second one considers the same problem for the junior high school; that is, for grades seven, eight and nine. The following principle is made fundamental in both reports:

> The primary purposes of the teaching of mathematics should be to develop those powers of understanding and analyzing relations of quantity and of space which are necessary to a better appreciation of the progress of civilization and a better understanding of life and of the universe about us, and to develop those habits of thinking which will make these powers effective in the life of the individual.

In the first report the following principle is also made basic:

> The courses in each year should be so planned as to give the pupil the most valuable mathematical information and training which he is capable of receiving in that year, with little reference to the courses which he may or may not take in succeeding years.

In the Junior High School Report, however, it is recommended that the work for the three years should be planned as a unit, in view of the fact that it may reasonably be expected that pupils will remain in the junior high school to the end of the ninth grade.

The application of these principles makes necessary a thoroughgoing reorganization of the content of courses. All topics, processes, and drill which do not directly contribute to the development of the powers mentioned in the first principle should, of course, be eliminated from the curriculum, and new material more appropriate to the purposes referred to should be introduced. In carrying out this application, the two reports contain detailed outlines as to topics which should be

included and as to the point of view which should govern the instruction. These reports have already been widely distributed and any further comment at this time would seem unnecessary.

3. "*Elective Courses in Mathematics for Secondary Schools.*"

This subject is in the hands of a subcommittee under the chairmanship of Professor C. N. Moore. The report, which is expected to be ready for publication in February, will consider the problem of the most desirable courses that should be offered by departments of mathematics in the later years of the secondary school, in particular in the last two years of the standard four-year high school and in the three years of the senior high school.

4. "*Mathematics in Junior Colleges.*"

This subject is in the hands of a subcommittee under the chairmanship of Mr. A. C. Olney, Commissioner of Secondary Education, California. The report is expected to be ready next spring.

5. "*The Function Concept in Secondary School Mathematics*," by E. R. Hedrick, University of Missouri.

In order to develop the "power of understanding and analyzing relations of quantity and of space" and the desired "habits of thinking," it is essential that the notion of the dependence of one quantity on another, *i.e.*, the notion of "functionality," be made fundamental in all mathematical instruction. Since this involves a radical departure from current practice, the Committee's recommendation that "the notion of relationship between variables be made the primary and underlying principle" of all courses in mathematics has called forth perhaps the greatest amount of comment. It seemed to the Committee desirable, therefore, to devote a special report to this topic, which would furnish teachers rather detailed information as to how this recommendation may be put into practice. The report will be ready for publication in January.

6. "*College Entrance Requirements in Mathematics.*"

The subject of this report, while obviously one with which the Committee would have to concern itself in any case, was deemed of such vital importance that the Councils both of the

Mathematical Association of America and of the American Mathematical Society specifically requested the Committee to take it up. The report gives the results of a rather extensive investigation into the needs of college departments, other than mathematics, regarding the mathematical preparation desired by them for students taking their elementary courses. On the basis of this investigation new definitions of entrance requirements in algebra have been formulated. It is gratifying to note that the problem of adequate preparation for college work as disclosed by the investigation mentioned does not conflict in any way with the recommendations made regarding the reorganization of courses in mathematics for secondary schools, which recommendations were formulated without any reference to college entrance requirements. In connection with the definition of the requirement in plane geometry a list of fundamental theorems and constructions has been prepared for the guidance of teachers and of examiners. This report has already been sent to the U. S. Bureau of Education for publication.

7. "*The Standardization of Terminology and Symbolism in Elementary Mathematics.*"

A report on this subject has been prepared by a subcommittee under the chairmanship of Professor David Eugene Smith, of Columbia University. It will be ready for publication in January.

8. "*The Present Status of Disciplinary Values in Education,*" by Vevia Blair, of the Horace Mann School, New York City.

This report will probably be ready for publication in February. It gives a critical review of all of the literature relating to the scientific investigation of the problem of disciplinary values and the transfer of training. On the basis of this review are formulated a number of propositions regarding transfer which seem to be justified by the experiments. These propositions have been submitted to leading psychologists in the country and have received the endorsement of the great majority of them. This report ought to be of great value in helping to bring order out of the chaos that has existed regard-

ing this subject for many years. It is obvious that the report has a large general educational significance and is not of interest merely to teachers of mathematics.

9. "*A Critical Study of the Correlation Method as Applied to Grades*," by A. R. Crathorne, University of Illinois.

Attempts to use the statistical method of correlation in the study of educational problems have been fairly numerous. The results in general have appeared, however, to be inconclusive. It appeared to the Committee distinctly worthwhile, therefore, to make a critical investigation of this method. To this end, Professor Crathorne undertook for the Committee the investigation of the correlations existing between a large number of pairs of subjects in the secondary school curriculum. In connection with this work nearly a thousand correlation coefficients have been computed. It is too early as yet to evaluate the results secured. They are being studied by a subcommittee consisting of Professor Crathorne, Professor C. N. Moore and Mr. Raleigh Schorling. Their report may be expected early in February.

10. "*Mathematics in Experimental Schools*," by Raleigh Schorling, The Lincoln School, New York City.

The recommendations of the Committee are based not on theoretical considerations alone but also on the actual experience of teachers throughout the country. It seems to the Committee that this experience should be made available to all teachers. Mr. Schorling was therefore requested by the Committee to prepare an extended report on the subject of the teaching of mathematics in experimental schools throughout the country. After a careful survey of the field, fourteen schools were selected as worthy of detailed consideration. Mr. Schorling's report will tell precisely what each of these fourteen schools is doing in the teaching of mathematics. It will give details as to the content of the curriculum, the equipment of the school, the training of the teachers employed, the cost of the instruction, the quality of students in the classes, etc. It is hoped that this report will be ready for publication in February or March.

11. "*World Experience Regarding Mathematical Curricula*," by J. C. Brown, State Normal School, St. Cloud, Minnesota.

This is an abstract of the report prepared on a similar subject by President Brown for the International Commission. It will be published as part of the Committee's final report.

12. "*The Training of Teachers*," by R. C. Archibald, Brown University.

Fundamentally the problem of better teaching must rest on the securing of better teachers. One of the very real obstacles in the way of reform in the teaching of mathematics lies in the fact that comparatively few teachers of this subject at the present time are adequately trained. Professor Archibald, who is already well-known for his report on the same subject which he prepared for the International Commission on Mathematics, is now making a very careful investigation of this subject for the Committee. His report will discuss actual conditions in all the states of the union and in a considerable number of the larger cities; will give information regarding the courses primarily intended for teachers given in colleges, universities, and normal schools and will make definite recommendations regarding such courses. It is hoped that this report will be ready for publication in February.

13. "*The Interests of High School Students*," by W. F. Downey, English High School, Boston, Mass.

The object of this investigation was to obtain from high-school pupils a statement regarding their interests and preferences in the study of mathematics. The schools selected for this investigation were of different types and sizes and geographically widely separated. In order to obtain an honest expression of opinion from the pupils, the replies were in writing without signature and those who conducted the inquiry in each school were asked to impress upon the pupils the purpose of the investigation. Replies were received from about 7000 pupils of fifteen high schools. In reply to the question "Do you like mathematics?" 84 per cent. answered in the affirmative. The investigation concerned itself further with the question as to what topics were liked most and the reasons therefore. Also

as to which subjects in the high-school curriculum were liked best. This investigation has been completed for some time but has not as yet been published.

14. "*Change of Mind between High School and College as to Life Work*," by A. R. Crathorne, University of Illinois.

Much of the agitation for the early introduction of vocational mathematics rests on the assumption that a considerable proportion of high-school pupils reach a decision early in their course as to what their life work is to be. It seemed desirable, therefore, to make an effort to find out to what extent this assumption is justified. Replies to a questionnaire were secured from over 2,000 college freshmen from eleven widely scattered states. Of these students, 57 per cent. had entered high school with some definite occupation in view. On entrance to college about one half of these had changed their minds. A summary of this investigation was published in *School and Society*, vol. XI, No. 262 (Jan. 3 ,1920), pp. 28–30, and the report in full was published in *Educational Administration and Supervision*, vol. VI, No. 5 (May–June, 1920), pp. 274–284.

15. "*The Importance of High School Mathematics as Indicated by Certain Questionnaires*," by Alfred Davis, Soldan High School, St. Louis, Mo.

A number of questionnaire investigations of interest to teachers of mathematics have recently been made and published. The Committee requested Mr. Davis to gather together in one report the results secured. His report includes, furthermore, an investigation made by himself but not hitherto published.

16. "*Bibliography*."

A bibliography on the teaching of mathematics covering all articles in a selected list of leading mathematical and educational journals since 1910 has been carefully prepared with the assistance of the graduate students in Professor Smith's classes at Teachers College, Columbia University. This bibliography will give not only the authors, titles and place of publication of the various articles but will also give brief synopses of them. It is expected that this report will be ready for publication in January.

A number of other projects are in various stages of preparation. Provost C. B. Upton of Teachers College, Columbia University, is engaged upon a report for the Committee which is intended to make available to teachers of mathematics information regarding various standardized tests which should be of value in connection with the teaching of mathematics. This informationn is at present widely scattered and it is believed that a real service will be done by bringing it together in convenient form. The Committee has further suggested the initiation of various investigations into the mathematical elements entering into the various professions, industries, occupations, etc. A memorandum on this subject has been sent to the various cooperating organizations, graduate schools of education, and the like, in the hope that some individuals or groups of individuals will see their way clear to undertaking such investigations which, if carried through in a thoroughly scientific spirit, would obviously be of great value.

This brief survey of the work of the Committee indicates that its various reports will all be completed by next spring. The remaining few months of its existence (until July 1, 1921) will be devoted to the revision of those reports which were of a preliminary character and the organization of the whole series into a single final report, if means can be found for its publication in a single volume.

The thought at once suggests itself, however, as to what agency will carry on the work initiated by the Committee. After all, the publication of our final report marks the beginning, not the end, of the real work. Who will see to it that our recommendations are put into practice? Who will observe the results and make the cumulative experience available for the guidance of all in further progressive improvement? How are adequately trained teachers to be secured in sufficient numbers? These are only a few of the many questions that thrust themselves on the consciousness of any one interested in the problem of placing the teaching of mathematics in a position of maximum service in the education of our citizenship.

The hundreds of teachers who have taken an active part in the work of the Committee during the last year and a half—and the thousands of others who have followed this work with

interest and hope—may surely be counted on to do all in their power to see to it that this work, begun under unusually favorable circumstances, is carried on with increased effectiveness in the years to come. It seems clear in the light of the experience of the last eighteen months that one of the things needed is nation-wide organization and another is energetic leadership. It is earnestly to be hoped that such organization and leadership can be found. Perhaps the National Council of Teachers of Mathematics has come into being at just the right time to help to carry this movement forward. It can almost certainly do so, if it receives the necessary support on the part of the teachers of mathematics throughout the country. There are probably some thirty thousand such teachers. If all of them, or one half of them, or even one fourth of them, were effectively organized and were ready to give a little of their money as well as their time to the cause, their influence for good, both to themselves individually, to their profession, and to their students, would be limited only by their wisdom and their enthusiasm.

J. W. YOUNG,
Chairman, National Committee on Mathematical Requirements.

DARTMOUTH COLLEGE.